

# In arid and semi-arid environments, restoration of salt-affected soils is a function of soil profile diagnosis and the residual sodium carbonate of irrigation water



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## INTRODUCTION

- Soil is a finite resource for agriculture. Arid and semi-arid regions are frequently affected by salinity/sodicity, resulting in reduced farm productivity and food security. About ~ 260 million ha of soils in Indo-Pak, Australia, Middle East, and The Near East and North Africa (NENA) region are affected by various forms of salinity/sodicity.
- Despite technological advancement and investments in salinity management, salinization is increasing, while crop productivity and food system resiliency are decreasing, which in places has led farmers to abandon farmland.
- Successful crop production requires efficient use of available resources, devising and implementing site-specific natural resource management (NRM) plans.
- We present here case studies of three management practices commonly used in the region that are unsustainable (Table 1) and present significant problems for the salt-affected soils (SAS).

## METHODOLOGY

- A survey conducted by the UN-Food and Agriculture Organization in Pakistan (2017-2019)
- Commodity-specific workshops held for the local farmers
- Dialogues held with salinity experts, the farming community, academics, and lead scientists of the key projects that were implemented in arid and semi-arid environments during 2000-2020. These projects focused on soil surface and sub-surface constraints (Fig 1, 2), salt precipitation index and quality of irrigation water indicated by electrical conductivity, sodium adsorption ratio (SAR), and residual sodium carbonate (RSC).

**Table 1.** Business-as-Usual - Common management practices associated with the geographical areas of case studies (Middle East, NENA, Australia, and Indo-Pak)

Practice	Description	Components
1	No pre-diagnosis of soil profile prior to grow salt-tolerant crop	<sup>a</sup> Prevention
2	Application of gypsum in standing rice crop	<sup>b</sup> Management
3	Less preference for RSC than EC, and SAR	<sup>c</sup> Rehabilitation/ Management

<sup>a</sup>District Sargodha, sub-district Shorkot, Punjab Pakistan; Cereals-based cropping system, Australia; <sup>b</sup>District Sargodha, sub-district Sahiwal; <sup>c</sup>Across all regions/study areas

## RESULTS

Crops sown on SAS were characterized by poor to stunted growth (Fig 3) and/or complete crop failure (even the salt-tolerant crops). With the application of gypsum in standing rice crops, burning was witnessed under saline condition (Fig 4). Increased patchy salinity, and decreased resiliency of overall production system was noticed with prolonged irrigation with high RSC water (Fig 5). A single irrigation @ 2.5 mmol<sub>c</sub> L<sup>-1</sup> RSC ~ 57.5 mg Na L<sup>-1</sup> can potentially add 219 kg ha<sup>-1</sup> of Na for wheat crop.



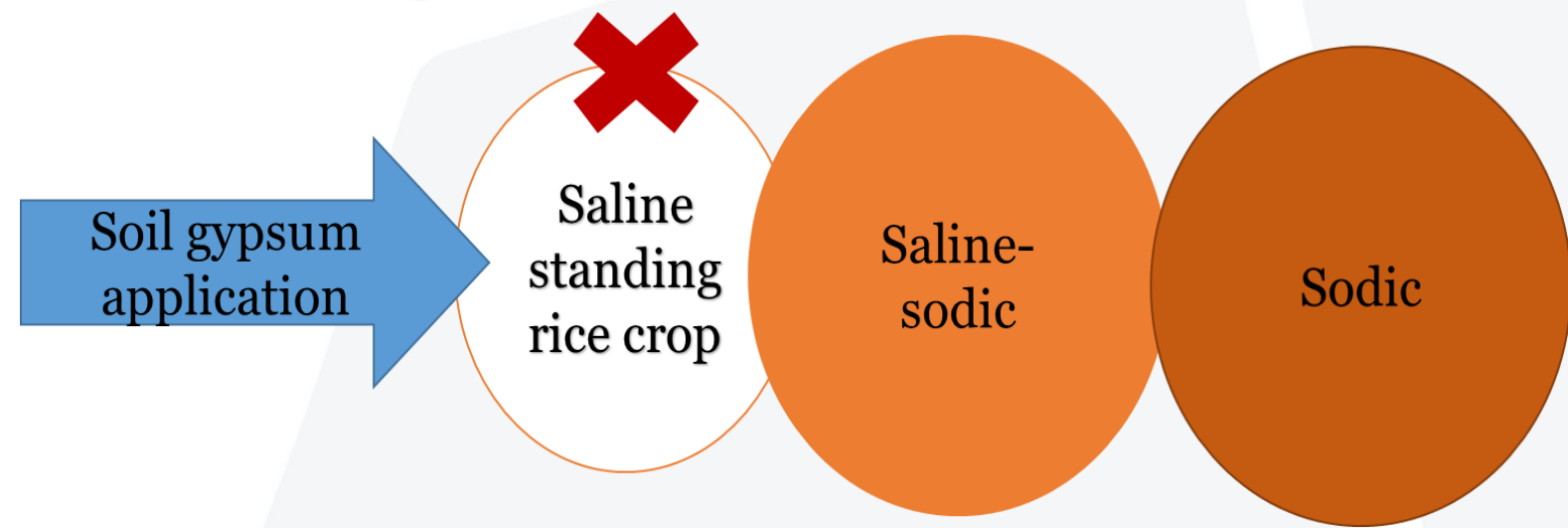
**Fig 1.** Duplex soils in Australia a main cause of sub-soil constraints and difficult to rehabilitate  
Source: Department of Primary Industries & Regional Development, Western Australia



**Fig 2.** Diagnostics of salinity/sodicity after crop failure – wrong strategy  
Courtesy: Dr. Shabbir A. Shahid



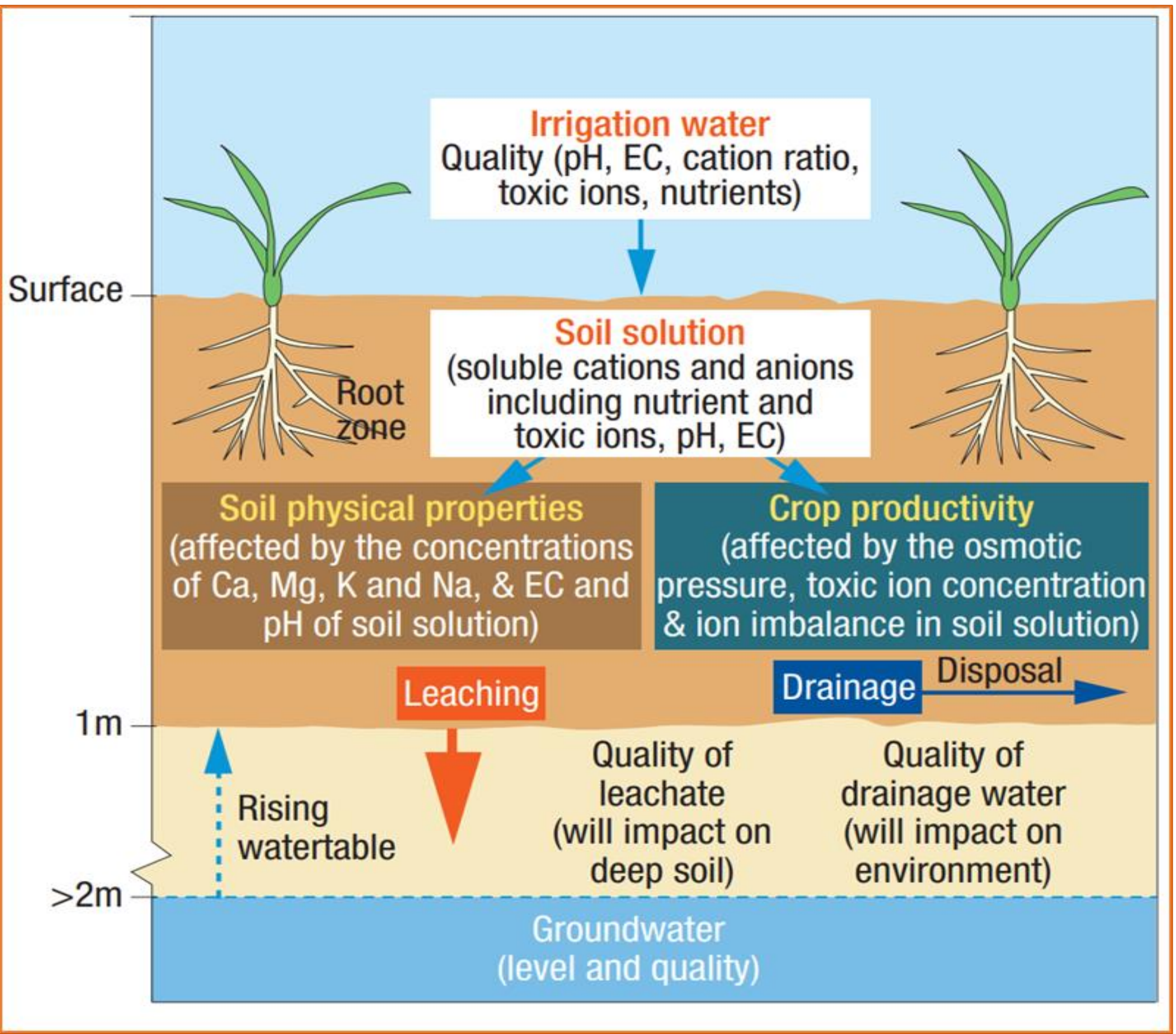
**Fig 3.** Poor growth of salt-tolerant barley crop due to no pre-diagnosis of the salinity/sodicity/problem  
Courtesy: Dr. Shabbir A. Shahid



**Fig 4.** Salt precipitation index increased in rice standing crop  
Source: Personal Observation of Rice Field (UNDP Biosaline-II Project)

## CONCLUSIONS

- The restoration of SAS is stage-wise process. Prevention, Management and Rehabilitation are 3-components to ultimately achieve the goal of complete restoration.
  - Region-specific NRM framework(s) should be implemented along with intensive trainings on soil profile diagnosis for the farmers and extension agents.
- Gypsum has been found most cost-effective, its application in standing rice crop should be discouraged.
- RSC of irrigation water is as important as its SAR, if not more than that.



**Fig 5.** Quality of irrigation water affects the soil solution composition, soil physical properties and crop productivity  
Source: Grains Research and Development Corporation, Australia

GLOBAL SYMPOSIUM ON  
SALT-AFFECTED SOILS

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